(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
31 January 2002 (31.01.2002)

PCT

(10) International Publication Number
WO 02/07860 A2

(51) International Patent Classification[7]: B01D 53/00

(21) International Application Number: PCT/IB01/01320

(22) International Filing Date: 24 July 2001 (24.07.2001)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
2000/3719 24 July 2000 (24.07.2000) ZA

(71) Applicant and
(72) Inventor: **STEWART, Shawn, Alan** [ZA/ZA]; 73 Donnelly Street, Turfontein, 2190 Gauteng (ZA).

(74) Agents: **GILSON, David, Grant** et al.; Spoor and Fisher, PO Box 41312, 2024 Craighall (ZA).

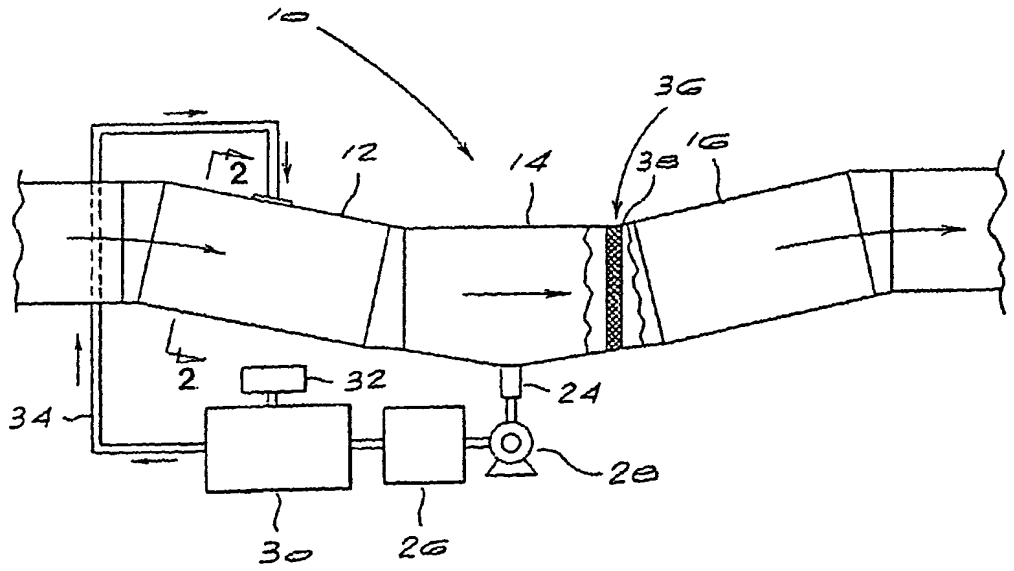
(81) Designated States *(national)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.

(84) Designated States *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:
— *without international search report and to be republished upon receipt of that report*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: A METHOD AND SYSTEM FOR PURIFYING OR CLEANSING A GAS STREAM OR GASEOUS BODY



(57) Abstract: A method and system for eliminating, in whole or in part, contaminants in a gas stream or gaseous body such as air or an exhaust gas or gas emission stream is provided. The method includes the steps of contacting the gas stream or gaseous body with a biocide containing liquid so as to eliminate, in whole or in part, the contaminant(s). The biocide containing liquid is typically an aqueous solution, suspension, or emulsion comprising hydrogen peroxide (H_2O_2) in combination with a catalyst for enhancing the activity thereof, the catalyst preferably comprising a superoxidedismutase formed from the combination of elemental copper (Cu), silver (Ag), manganese (Mn) and zinc (Zn). The method and system find particular application in the combating of sick building syndrome (SBI) and building related illness (BRI).

WO 02/07860 A2

A METHOD AND SYSTEM FOR PURIFYING OR CLEANSING A GAS STREAM OR GASEOUS BODY

BACKGROUND OF THE INVENTION

THIS invention relates to a method and system for purifying or cleansing a gas stream or gaseous body containing one or more contaminants.

It is well established that outdoor air pollution can cause serious human illness. Air pollution can cause burning eyes and noses, itchy irritated throats as well as breathing difficulties. Some chemicals can cause cancer, birth defects, brain and nerve damage, long-term injury to lungs and even premature death. As a result, protection of the public health is a driving force behind the laws and regulations that are being, and have been, put into place to clean up the environment. However, ridding outdoor air toxic contaminants has often overlooked indoor air quality (IAQ).

The results of numerous scientific investigations have revealed many reported outbreaks of what is known as Sick Building Syndrome (SBS) and Building Related Illness (BRI) as a direct result of indoor air pollution (IAP) in office and other public access buildings.

SBS is used to describe the situation in which building occupants experience acute health and comfort defects that are linked to time spent in the building. BRI is the term used when diagnosable illness and symptoms are identified and directly attributed to airborne building material contaminants.

In modern society, it is believed that most people spend as much as 90% of their time indoors. The US Environmental Protection Agency (EPA) has indicated that IAP may be between 2-5 times higher than accepted levels, and up to 100 times higher than outdoor pollution levels.

The World Health Organisation (WHO) Committee Report on IAQ suggested that 30% of new and re-modelled buildings globally are subject to excessive complaints of IAQ and have unusually high rates of SBS and/or BRI. For example, according to the SA Singapore embassy, 92% of all absenteeism in Singapore can be attributed to SBS and/or BRI.

IAQ is rated within the top 5 of the US EPA's most critical global concerns alongside ozone depletion, global warming and the like. It has been reported, for instance, that in 1989, the US economy suffered a staggering US $65 bn loss due to SBS and BRI. The absenteeism levels, due to poor health caused by IAP, resulted in this huge productivity decrease.

SUMMARY OF THE INVENTION

According to the invention, a method of purifying or cleansing a stream of gas or gaseous body containing one or more contaminants, in particular air or an exhaust gas stream, includes the steps of contacting the gas stream or gaseous body with a biocide containing liquid so as to eliminate, in whole or in part, the contaminant(s).

The biocide containing liquid is preferably an aqueous solution, suspension or emulsion of the biocide.

The biocide preferably comprises hydrogen peroxide (H_2O_2) in combination with a catalyst for enhancing the activity thereof, the catalyst preferably comprising a superoxidedismutase formed from the combination of elemental copper (Cu), silver (Ag), manganese (Mn) and zinc (Zn).

The H_2O_2 is typically present in the biocide in an amount of about 0.000003% to about 15% v/v, preferably about 0.003% to about 3% v/v, in particular about 0.3% v/v.

The Cu, Mn and Zn are typically present in an amount of about 100ppb to about 1000ppm, preferably about 3 to 7ppm, in particular about 5ppm.

The Ag is typically present in an amount of about 100ppb to about 1000ppm, preferably about 3 to 9 ppm, in particular about 7ppm.

The liquid biocide is preferably provided in the form of a fine spray or mist.

The method is preferably used to purify the air in an air conditioning unit of a building such as an office block, house, hospital, shopping mall, stadium, or the like, a vehicle such as a motor vehicle, bus, truck, ship or train, an aircraft or the like, in mines and other underground environments or an exhaust gas or other gas emission from an industrial factory or the like.

The invention extends to a system for purifying a gas stream or gaseous body, the system including a gas purifying unit arranged to bring a liquid biocide into contact with a gas stream or gaseous body passing through the unit in order to eliminate, in whole or in part, contaminants in the gas stream or gaseous body.

The method and system find particular application in the elimination of contaminants selected from inorganic contaminants such as CO, NO_2 and SO_2, organic contaminants such as formaldehyde, hexane and acetone, particulate matter such as dust particles and smoke particles, and micro-organisms such as viruses for example influenza, small pox and the like, bacteria, for example legionella and other airborne bacteria, and fungi or their spores, in particular anaerobic micro-organisms.

The method and system are preferably used in the combating of sick building syndrome (SBI) and building related illness (BRI).

An embodiment of the invention is described in detail in the following passages of the specification which refer to the accompanying drawings. The drawings, however, are merely illustrative of how the invention might be put into effect, so that the specific form and arrangement of the features shown is not to be understood as limiting on the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will now be described in more detail, by way of example only, with reference to the accompany drawings in which:

Figure 1 is a schematic side view of a gas purification system of the invention; and

Figure 2 is a cross-sectional view on the line 2-2 of Figure 1.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

The invention provides a method and system for eliminating, in whole or in part, contaminants in a gas stream or gaseous body such as air or an exhaust gas or gas emission stream.

Referring to Figure 1 of the drawings, a gas purification system 10 of the invention is shown schematically. The system 10 consists of a scrubber unit 12, as shown more clearly in Figure 2, a liquid collection unit 14 and an air dryer unit 16 (optional), all in gas flow communication with one another.

The scrubber unit 12 includes a plurality of spray nozzles 18 for introducing a fine spray or mist 20 of a biocide solution, suspension or emulsion into the scrubber chamber 22 thereof. As air or other gas containing contaminants passes through the scrubber 12, in the direction of the arrows in Figure 1, it contacts the spray or mist. As the contaminants in the gas or air stream come into contact with the fine mist or spray, they are taken up by the spray or mist droplets and hence removed from the air stream. In addition, the biocide acts to kill the micro-organisms. The biocide solution, typically including water as the carrier, collects under normal gravitational forces in the collection unit 14 whereafter it flows through outlet conduit 24 and is pumped into a filter unit 26 by a pump 28. The contaminants in the solution are removed in the filter 26 whereafter the water is pumped into the water feed tank 30. A biocide feeder 32, typically in the form of a drip supply tank, feeds biocide into the water in the tank 30 before it is pumped via the conduit 34 into the scrubber unit 12. The collection unit 14 includes a water separator 36 at a front end 38 thereof for separating excess water droplets as the air stream exits the collection unit 14. The decontaminated air passing from the collection unit 14 may have a relatively high relative humidity, in which case it is optional to pass it through a heating chamber or dryer unit 16 before

continuing through the rest of the air conditioning system.

It is envisaged that the method and system of the invention can be used to eliminate, in whole or in part, a number of contaminants including inorganic contaminants such as CO, NO_2 and SO_2, organic contaminants such as formaldehyde, hexane and acetone, particulate matter such as dust particles and smoke particles, and micro-organisms such as viruses for example influenza, small pox and the like, bacteria, for example legionella and other airborne bacteria, and fungi or their spores, in particular anaerobic micro-organisms. The combination of biocide, which acts on the micro-organisms, and the fine spray, which acts to remove particles out of the air, are believed to provide an effective air or gas purification method and system.

In order to evaluate the efficacy of the system and method of the invention, the applicant retained the services of an independent, fully accredited testing company (Environmental Science Service Consultants ESSC) to conduct tests on air containing a number of different contaminants. In terms of the methodology, the following pollutants were introduced into the air:

Inorganic gasses: CO, NO_2, SO_2;
Organic gasses: formaldehyde, hexane and acetone;
Particulate matter: dust of various particle sizes and tobacco smoke; and
Micro-organisms.

The tests were carried out using a prototype which was built as a self-contained, re-circulatory unit housing +/- 12 m^3 of air volume. Airflow through the prototype was maintained at +/- 0.5 m^3/s at a speed of +/- 2 m/s, producing a 6 second air change. This allowed for the production of a ten air change cycle every minute, forming a 1 minute = 1 hour ratio. Thus, for

every minute that the unit circulated the air, it was equivalent to 1 hour in real time. Hence, 24 minute exposure time equates into one day or a 24 hour period.

The results of the tests are set out below.

Table 1: Inorganic contaminants elimination per 24 hour period

CONTAMINANT	PERCENTAGE ELIMINATION
Sulphur dioxide (SO_2)	58%
Carbon monoxide (CO)	76%
Oxygen (O_2)	0.5% increase
Nitrogen dioxide (NO_2)	91% elimination
Carbon dioxide (CO_2)	Pending

Table 2: Organic contaminants elimination per 5 hour cycle

CONTAMINANT	PRE-TEST (ppm)	POST-TEST (ppm)	REDUCTION (ppm)	PERCENTAGE ELIMINATION
Formaldehyde	-	-	-	Pending
Hexane	1825.6	1125	-700.6	38.3%
Acetone	2941.2	36.6	-2904.6	98.75%

Table 3: Particulate material

CONTAMINANT	PERCENTAGE ELIMINATION
Fine dust particles	99.9%
Coarse dust particles	99.9%

In addition to the above contaminants, bacterial microbes from toilet water of various contamination degrees were brought into contact with the biocide solution in one passage of airflow through the system and a 99.9% elimination was obtained.

In the light of the above test results, it is believed that the method and system of the invention are capable of eliminating, at least in part, micro-organisms and harmful gasses that cause sick building syndrome and related illness. The system is relatively inexpensive to manufacture and the chemical compounds for the biocide are readily available and cost effective. The chemicals used are human-safe, non-toxic and provided in quantities which are well below OSHA regulations.

CLAIMS

1. A method of purifying or cleansing a stream of gas or a gaseous body containing one or more contaminants, includes the steps of contacting the gas stream or gaseous body with a biocide containing liquid so as to eliminate, in whole or in part, the contaminant(s).

2. A method according to claim 1, wherein the stream of gas is an air stream or an exhaust gas stream.

3. A method according to claim 1 or claim 2, wherein the biocide containing liquid is an aqueous solution, suspension or emulsion of the biocide.

4. A method according to any one of claims 1 to 3, wherein the biocide comprises hydrogen peroxide (H_2O_2) in combination with a catalyst for enhancing the activity thereof.

5. A method according to claim 4, wherein the catalyst comprises a superoxidedismutase formed from the combination of elemental copper (Cu), silver (Ag), manganese (Mn) and zinc (Zn).

6. A method according to claim 5, wherein the biocide comprises about 0.000003% to about 15% v/v H_2O_2, and about 100 ppb to about 1000 ppm each of Cu, Mn, Zn and Ag.

7. A method according to claim 6, wherein the biocide comprises about 0.003% to about 3% v/v H_2O_2, about 3 to 7 ppm each of Cu, Mn and Zn, and about 3 to 9 ppm Ag.

8. A method according to claim 7, wherein the biocide comprises about 3% v/v H_2O_2, about 5 ppm each of Cu, Mn and Zn, and about 7 ppm Ag.

9. A method according to any one of claims 1 to 8, wherein the liquid biocide is provided in the form of a fine mist or spray.

10. A method according to any one of claims 1 to 9, wherein the method is used to purify the air in an air conditioning unit of a building, vehicle, an aircraft, in mines, and other underground environments or an exhaust gas or other gas emission from an industrial factory or the like.

11. A method according to any one of claims 1 to 10, wherein the contaminants are selected from the group comprising inorganic contaminants, organic contaminants, particulate matter and micro-organisms.

12. A method according to claim 11, wherein the contaminants are selected from the group comprising CO, NO_2, SO_2, formaldehyde, hexane, acetone, dust particles, smoke particles, viruses, bacteria, and fungi or their spores.

13. A method according to any one of claims 1 to 12 for use in combating sick building syndrome or building related illness.

14. A system for purifying a gas stream or gaseous body, the system including a gas purifying unit arranged to bring a liquid biocide into contact with a gas stream or gaseous body passing through the unit in order to eliminate, in whole or in part, contaminants in the gas stream or gaseous body.

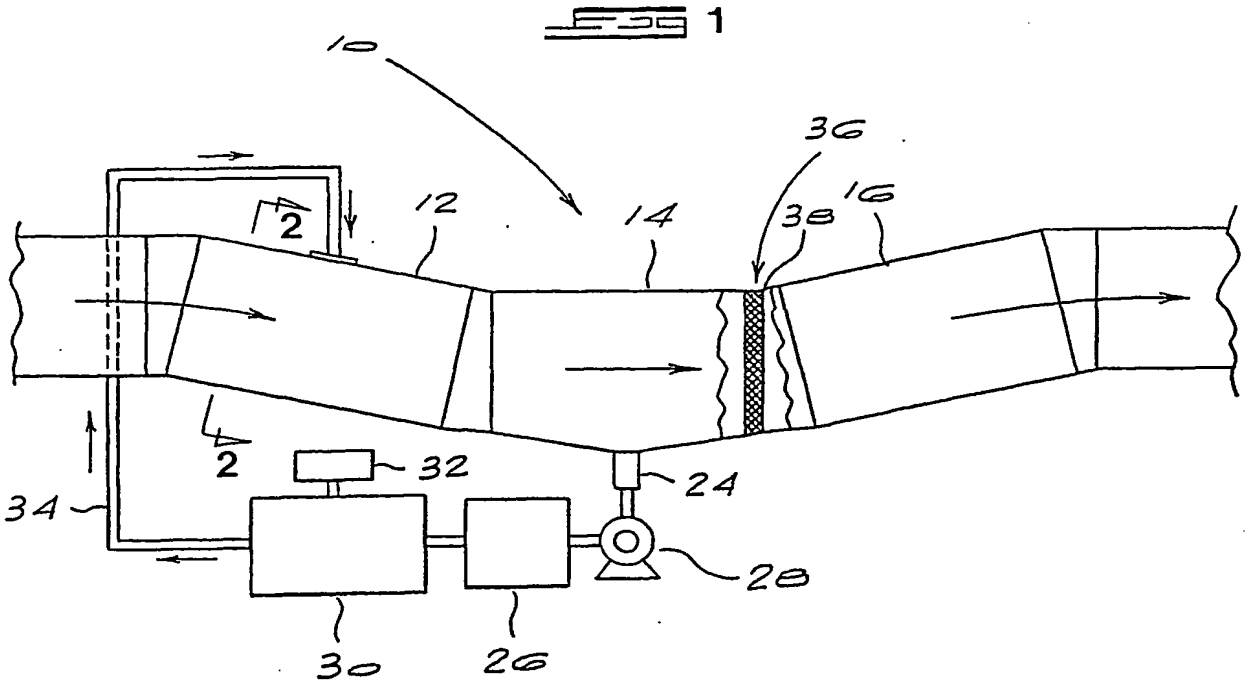


Fig 1

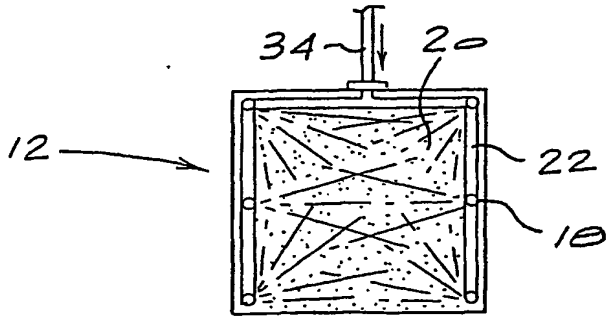


Fig 2

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
31 January 2002 (31.01.2002)

PCT

(10) International Publication Number
WO 02/007860 A3

(51) International Patent Classification[7]: B01D 53/14

(21) International Application Number: PCT/IB01/01320

(22) International Filing Date: 24 July 2001 (24.07.2001)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
2000/3719 24 July 2000 (24.07.2000) ZA

(71) Applicant and
(72) Inventor: **STEWART, Shawn, Alan** [ZA/ZA]; 73 Donnelly Street, Turfontein, 2190 Gauteng (ZA).

(74) Agents: **GILSON, David, Grant** et al.; Spoor and Fisher, PO Box 41312, 2024 Craighall (ZA).

(81) Designated States *(national)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.

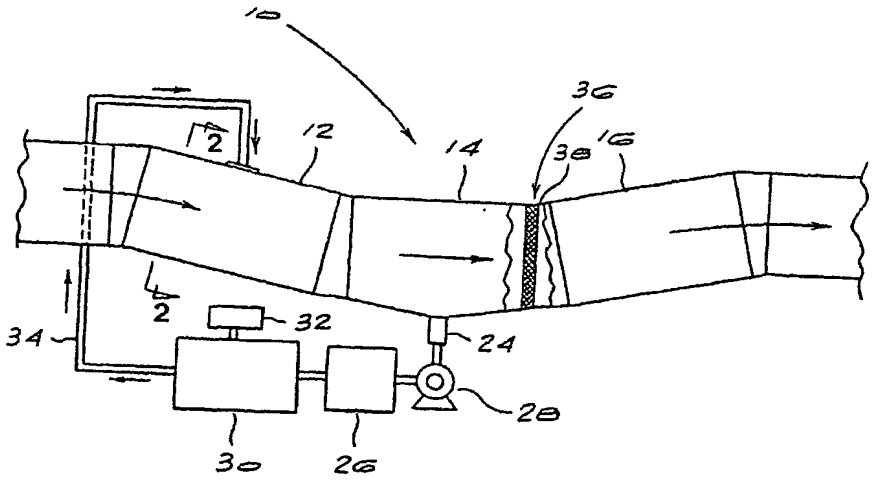
(84) Designated States *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:
— *with international search report*

(88) Date of publication of the international search report:
22 August 2002

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: A METHOD AND SYSTEM FOR PURIFYING OR CLEANSING A GAS STREAM OR GASEOUS BODY



(57) Abstract: A method and system for eliminating, in whole or in part, contaminants in a gas stream or gaseous body such as air or an exhaust gas or gas emission stream is provided. The method includes the steps of contacting the gas stream or gaseous body with a biocide containing liquid so as to eliminate, in whole or in part, the contaminant(s). The biocide containing liquid is typically an aqueous solution, suspension, or emulsion comprising hydrogen peroxide (H_2O_2) in combination with a catalyst for enhancing the activity thereof, the catalyst preferably comprising a superoxidedismutase formed from the combination of elemental copper (Cu), silver (Ag), manganese (Mn) and zinc (Zn). The method and system find particular application in the combating of sick building syndrome (SBI) and building related illness (BRI).

WO 02/007860 A3

INTERNATIONAL SEARCH REPORT

Int ɔnal Application No
PCT/IB 01/01320

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 B01D53/14

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 B01D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 88 10122 A (COMMW IND GASES) 29 December 1988 (1988-12-29) page 3, line 1-13	1
A	US 4 107 268 A (O NEILL EUGENE T ET AL) 15 August 1978 (1978-08-15) claims 1,2	1
A	US 3 911 080 A (HALFAR KURT ET AL) 7 October 1975 (1975-10-07) claims 1,3	1
A	EP 0 620 037 A (MICHAILOW ALEXANDER) 19 October 1994 (1994-10-19) column 3, line 19 - line 28	1

-/--

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
24 January 2002	08/02/2002

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Clement, J-P

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

International Application No
PCT/IB 01/01320

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
A	GB 1 456 057 A (ELEKTROKEMISKA AB) 17 November 1976 (1976-11-17) claim 1 ---	1
A	DATABASE WPI Section PQ, Week 199413 Derwent Publications Ltd., London, GB; Class Q49, AN 1994-108425 XP002187500 & SU 1 793 067 A (MINING IND SAFETY RES INST), 7 February 1993 (1993-02-07) abstract -----	1

Form PCT/ISA/210 (continuation of second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

nformation on patent family members

Int onal Application No
PCT/IB 01/01320

Patent document cited in search report		Publication date	Patent family member(s)		Publication date
WO 8810122	A	29-12-1988	AU	608630 B2	11-04-1991
			AU	1958688 A	19-01-1989
			WO	8810122 A1	29-12-1988
			CA	1337044 A1	19-09-1995
			DE	3851533 D1	20-10-1994
			DE	3851533 T2	16-02-1995
			EP	0368876 A1	23-05-1990
			ES	2009201 A6	01-09-1989
			GR	88100399 A	08-03-1989
			JP	2503873 T	15-11-1990
			JP	2604458 B2	30-04-1997
			NZ	225086 A	27-11-1990
			PH	24792 A	30-10-1990
			PT	87796 A ,B	01-07-1988
			ZA	8804405 A	30-05-1989
US 4107268	A	15-08-1978	BE	856658 A1	09-01-1978
			CA	1083473 A1	12-08-1980
			DE	2730947 A1	12-01-1978
			ES	460530 A1	16-05-1978
			FR	2357827 A1	03-02-1978
			IT	1082119 B	21-05-1985
			JP	945653 C	30-03-1979
			JP	53007957 A	24-01-1978
			JP	53024729 B	22-07-1978
			NL	7707201 A	11-01-1978
			SE	7708057 A	10-01-1978
US 3911080	A	07-10-1975	AU	4652272 A	21-03-1974
			CH	556170 A	29-11-1974
			DE	2241340 A1	15-03-1973
			FR	2152829 A1	27-04-1973
			GB	1399214 A	25-06-1975
			IT	967218 B	28-02-1974
			JP	48037363 A	01-06-1973
			NL	7212288 A	13-03-1973
			ZA	7205402 A	25-04-1973
EP 0620037	A	19-10-1994	DE	4343607 A1	20-10-1994
			EP	0620037 A2	19-10-1994
GB 1456057	A	17-11-1976	SE	377891 B	04-08-1975
			DE	2453434 A1	22-05-1975
			DK	587374 A	21-07-1975
			FI	328674 A	17-05-1975
			FR	2251352 A1	13-06-1975
			JP	50080962 A	01-07-1975
			NO	744123 A	16-06-1975
			SE	7315554 A	20-05-1975
SU 1793067	A	07-02-1993	SU	1793067 A1	07-02-1993